REMARKS

Claims 1-3 and 5 have been rejected under 35 USC 103(a) as being unpatentable over Amelio et al in view of Verbunt. Claims 1-3 and 5 also have been rejected under 35 USC 103(a) as being unpatentable over JP '779. Claims 1-3 and 5 have been provisionally rejected on the ground of nonstatutory obviousness-type double patenting over Claims 5 and 6 of application Serial No. 10/576 230 in view of Amelio et al. Claims 1, 2 and 5 have been rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-3 of application Serial No. 12/075 745. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to an electroless copper plating solution containing a water-soluble nitrogen-containing polymer and glyoxylic acid and phosphinic acid as reducing agents. The presently claimed invention is also directed to an electroless copper plating method for depositing a copper plating on a substrate in which the improvement comprises performing the electroless copper plating with the electroless copper plating solution of the present invention.

As explained previously, the instant invention is based on the discovery that when a water-soluble nitrogen-containing polymer is added to an electroless copper plating solution also containing phosphinic acid and glyoxylic acid as reducing agents, the initial plating reactivity through the catalyst metal is higher and a uniform plating at lower temperatures on a semiconductor or other mirror-surfaced substrate can be realized. It is believed that this occurs due to the catalyst metal being made to adhere to the substrate prior to immersion so that the water-soluble nitrogen-containing polymer in the plating solution is absorbed over the catalyst metal via nitrogen atoms. As a result, the plating deposition speed is

reduced, the crystals become finer and the adhesion of the plating to a wafer or other mirrored surface substrate increased. It is respectfully submitted that the presently claimed invention is patentably distinguishable over the prior art cited by the Examiner.

The Amelio reference discloses an electroless copper plating bath comprising a cationic polymer from acrylamide and/or methacrylamide. The plating bath can also contain a cupric ion source, a reducing agent for the cupric ion source and a complexing agent for the cupric ion. This reference further discloses that the most common reducing agent employed is formaldehyde with other reducing agents such as formaldehyde derivatives or precursors, trioxane, dimethylhydantoin and gloxal, borohydrides and boranes also being suitable. As admitted by the Examiner, Amelio et al does not disclose a reducing agent comprising both glyoxylic acid and phosphinic acid. Additionally, the water-soluble nitrogen-containing compound can have a relatively high molecular weight of about 50,000 to 1,000,000 or more. As admitted by the Examiner, this reference does not disclose a reducing agent comprising both glyoxylic acid and phosphinic acid in combination with the nitrogen-containing polymer.

The Verbunt reference discloses a copper bath composition comprising water, copper ions, hydroxide ions, a complexing agent to inhibit the formation of copper oxides, copper hydroxides and copper salts, a stabilizer to control the rate of electroless copper plating, a reducing agent to promote electroless reduction of the copper ions to copper metal and a catalyst to promote the electrolytic reduction of copper ions to copper metal. The reducing agent is selected from the group consisting of glyoxylic acid, dimethylamine borane, hypophosphite, borohydride, hydrazine and mixtures thereof. However, the Verbunt reference does not disclose the presence of the water-soluble nitrogen-containing polymer in the plating solution.

JP '779 discloses an electroless copper plating bath consisting of a copper oxide, a reducing agent such as hydrazine and a complexing agent consisting of polyethyleneimine having a molecular weight of from several hundred to several hundred thousand. However, like the previously discussed Amelio et al reference, this reference has no disclosure with respect to containing glyoxylic acid and phosphinic acid as reducing agents. To supply this teaching, the Examiner has once again cited the Verbunt reference.

Claims 5 and 6 of application Serial No. 10/576 230 disclose an electroless copper plating method which utilizes an electroless copper plating solution comprising a first reducing agent, hypophosphorus acid or a hypophosphyte as a second reducing agent and a stabilizer for inhibiting copper deposition. The first reducing agent can be glyoxylic acid, the second reducing agent can be hypophosphoric acid and the stabilizer can be 2,2'-bipyridyl. As pointed out by the Examiner, the claims of this application do not disclose the provision of a water-soluble nitrogen-containing polymer in the solution. To supply this teaching, the Amelio et al reference has been cited.

Claims 1, 2 and 5 of application Serial No. 12/075 745 disclose an electroless plating solution comprising a water-soluble nitrogen-containing polymer and glyoxylic acid and phosphinic acid as reducing agents wherein the weight average molecular weight of the water-soluble nitrogen-containing polymer is from 1,000 to less than 100,000.

Applicants respectfully traverse all of these grounds of rejection and urge that given the evidence of unobviousness presented in the present specification, any proper showing of prima facie obviousness under 35 USC 103(a) has been rebutted.

The currently presented specification contains Examples and Comparative Examples which establish the unobviousness of the presently claimed invention.

In the bath composition disclosed in Verbunt, glyoxylic acid and phosphinic acid as reducing agents are used. However, no water-soluble nitrogen-containing polymer is added. This is similar to that of Comparative Example 1 of the present specification. In Comparative Example 1, glyoxylic acid and phosphinic acid are used as reducing agents and a water-soluble nitrogen-containing polymer is not added. However, the plating film formed using the plating bath of Comparative Example 1 was found to have problems such as peeling, poor adhesion and the trench portions of the film not being fully embedded.

The bath composition disclosed in JP '779 contains formalin as a reducing agent and polyethyleneimine as a water-soluble nitrogen-containing polymer. This is similar to that for Example 5 of the present specification. However, the plating film formed using this plating bath was found to be deposited in little islands and many portions without deposition were observed.

The bath composition of Example 4 is similar to that of Amelio et al. Example 4 shows the results of a bath containing glyoxylic acid and polyacrylamide but not including phosphinic acid. Amelio teaches the use of formaldehyde as a reducing agent and a polyacrylamide in the plating solution. However, as formaldehyde is well known to have characteristics similar to glyoxylic acid, Example 4 is considered to be equivalent to Amelio's plating bath. The plating film formed using the bath composition of Example 4 was deposited in little islands and many portions without deposition were observed.

The bath composition of Verbunt used glyoxylic acid and phosphinic acid as reducing agents, with no water-soluble nitrogen-containing polymer being added. This was shown to be similar to that for Comparative Example 1 and the plating film formed there had problems. Accordingly, there is no reasonable expectation of success of achieving the superior properties of the invention, such as an improved adhesion

strength and uniformity of the plating, and reactivity at a lower temperature, by applying the combination of the reducing agents taught in Verbunt's bath composition to Amelio's bath composition comprising polyacrylamide as a water-soluble nitrogen-containing polymer.

The embodiment of Example 5 of the present specification is similar to that for JP '779 and the bath composition of Example 5 produced poor plating results. The bath composition of Verbunt using glyoxylic acid and phosphinic acid as reducing agents with no water-soluble nitrogen-containing polymer was shown to be similar to that for Comparative Example 1, and the plating film formed therein had problems. Accordingly, there is no reasonable expectation of the superior properties of the present invention of improved adhesive strength and uniformity of the plating and reactivity at lower temperature by applying the combination of the reducing agents taught in Verbunt's bath composition to JP '779's bath composition comprising polyethyleneimine as a water-soluble nitrogen-containing polymer.

The present invention is characterized in that the three elements of glyoxylic acid, phosphinic acid, and water-soluble nitrogen-containing polymer in the plating solution make it possible to improve the adhesive strength and uniformity of the plating, and reactivity at a lower temperature, which are unexpected synergistic effects caused by the three elements. These effects are not expected from any of the cited prior arts, and there is no teaching, suggestion nor motivation of achieving the effects of the present invention in any of the cited prior arts, either.

The Examiner asserts in "Response to Arguments" that "in each of the examples, the same substrate is used, and the substrate has a specific pretreatment method using a silane coupling agent, which is not required by the present claims, and it has not been shown that the same effects would occur with other substrates or pretreatments". The wafer in the Examples of the present specification is a silicon wafer with

a tantalum nitride film. This kind of silicon wafer is widely used as a plating substrate. The silane coupling agent used in the pretreatment disclosed in the Examples is also well known. In the Examples, the same substrate was used and the same pretreatment was performed. However, the substrate and the pretreatment were used to show the particular effect of the present invention, i.e., the presence of glyoxylic acid, phosphinic acid and the water-soluble nitrogen-containing polymer in the plating solution. A person skilled in the art would understand that the effect presented in the Examples are caused by the three necessary components and the same effects would occur when other similar substrates and pretreatments are applied. It is not practical to limit the substrate and pretreatment method to the embodiment disclosed in the Examples. Similarly, such substances as EDTA, 2,2-bipyridyl and copper sulfate are normally used in plating baths. A person skilled in the art would understand that chelating agents, stabilizing agents and copper sources of similar kinds can be applied without affecting the results caused by the combination of the three elements of the present invention.

The Examiner further asserts that "in each of the examples, the only water soluble nitrogen containing polymer is polyacrylamide or polyethyleneimine". However, as disclosed in paragraph [0011] of the present specification, other water-soluble nitrogen-containing polymers such as polyacrylamide, polyethyleneimine, polyvinylpyrrolidone, polyvinylpyridine, polyacrylonitrile, polyvinylcarbazole, and polyvinylpyrrolidinone are also effective in the present invention. There is no point of limiting the water-soluble nitrogen-containing polymer to polyacrylamide or polyethyleneimine just because the Examples use only polyacrylamide or polyethyleneimine.

For the reasons advanced above, it is respectfully submitted that the objective evidence of record in the present application is more than sufficient to show the patentability of the presently claimed invention over any prima facie

obviousness rejection made by the Examiner under 35 USC 103(a). Favorable consideration is respectfully solicited.

Respectfully submitted,

Terryence F. Chapman

TFC/smd

FLYNN, THIEL, BOUTELL & TANIS, P.C.
2026 Rambling Road
Kalamazoo, MI 49008-1631
Phone: (269) 381-1156
Fax: (269) 381-5465

David G. Boutell	Reg. No. 25 072
Terryence F. Chapman	Reg. No. 32 549
Mark L. Maki	Reg. No. 36 589
Liane L. Churney	Reg. No. 40 694
John A. Waters	Reg. No. 24 802
Brian R. Tumm	Reg. No. 36 328
Donald J. Wallace	Reg. No. 43 977
Dale H. Thiel	Reg. No. 24 323
Sidney B. Williams, Jr.	Reg. No. 24 949
Heon Jekal	Reg. No. L0379*

*limited recognition number

Encl: Postal Card

110.10/07